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ABSTRACT

An educational methodology for the development of interdisciplinary, problem-solving skills was developed. Called the problem laboratory, the approach focuses on linking the student with the real problems of real organizations through specifically designed data bases. Students are presented with a brief problem statement and proceed to solve the problem by querying the data base. The problem laboratory approach has been found to be successful in two years of operation in an experimental setting. Some of the difficulties of operating this type of program on an experimental basis are described along with problems that must be solved before large scale expansion can occur. (Author/WH)

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INFORMATION SYSTEMS FOR PROBLEM-ORIENTED, INTERDISCIPLINARY EDUCATION

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Abstract

This paper describes an educational methodology for the development of interdisciplinary, problem-solving skills. The Problem Laboratory approach focuses upon linking the student with the real problems of real organizations through specially designed data bases. Students are presented with a brief problem statement and proceed to solve the problem by querying the data base.

The Problem Laboratory approach has been found to be successful in two years of operation in an experimental setting. This paper describes some of the difficulties of operating this type of program on an experimental basis, and some of the problems that must be solved before large scale expansion can occur.

INTRODUCTION

Many academic programs such as those in business or engineering are designed to produce problem-solvers. Typically, however, the curricula for these programs expose the student to only narrow, artifical problem situations. Furthermore, these problems are usually handled in a narrow disciplinary context. Students are rarely forced to deal with real, complex problems in an interdisciplinary or even multidisciplinary fashion.

Attempts have been made to increase the student's experience with complex problem situations. On one level, cooperative and internship programs have been developed which expose the student to the day by day problems of an organization. While this type of program has considerable academic and financial merit, it does have limitations. The more notable of these limitations are the lack of integration of academic content with the job experience and the lack of control over the job environment.

On a second level, students have been exposed to complex problems through such techniques as simulation and case analyses. Simulations tend to be somewhat artificial. Indeed, the term "simulation game" which is frequently used to describe such simulations reflects that artificiality. Cases, while frequently less artificial, also have difficulties. Cases describe problem situations that existed several years ago. Students frequently have difficulty in recognizing such situations as real. Furthermore, cases tend to contain a limited information base which again introduces an artificial environment.

Not only do cases and simulations have inherent limitations, but they also tend to be used in an academic environment with an extremely narrow disciplinary bias. For example, cases used in marketing courses are developed for marketing courses and reflect that orientation. Many such cases are even written to emphasize a very narrow problem, concept or technique. Much worse, however, is that the student knows that it is a marketing case, should be approached as a marketing case, and, most likely, has a marketing solution.

The student typically, of course, responds with a marketing analysis and a marketing solution. Concepts of finance, accounting, and organizational behavior which he is studying in other courses are temporarily ignored because they are viewed as irrelevant. Indeed given the structure of the course or the particular instructor involved, they may well be irrelevant. Neither the problem nor the environment are conducive to an interdisciplinary effort.

This paper describes a Problem Laboratory technique for the development of interdisciplinary problem-solving skills. The Problem Laboratory format centers around a carefully constructed data base and information retrieval system which the student uses to interact with real problems of real organizations. This system is used in the context of a multidisciplinary environment which encourages the student to examine multiple facets of a problem situation.

The Problem Laboratory approach has been successfully implemented in the context of an undergraduate business curriculum as the Management Problem Laboratory (MPL) at Southern Illinois University at Edwardsville. The concept is now being integrated as the Urban Problem Laboratory into a new graduate program in Urban Studies which emphasizes an interdisciplinary approach to urban problems. The Problem Laboratory methodology is adaptable to many problem areas and transportable to many environments.

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THE PROBLEM LABORATORY

The Problem Laboratory is both a concept and a physical entity. As a concept it is a problem-oriented integrating force of a multidisciplinary program. As a physical entity it is a data base, data maintenance system, and information retrieval system. Both aspects are best described in terms of a specific program structure. The following sections describe the Problem Laboratory in terms of the business program and the planned implementation in the urban studies program.

The Problem Laboratory Concept

As discussed, the case method is limited by its artificial nature, restricted data, and usual single discipline orientation. In the Management Problem Laboratory students work on real problems of real organizations simultaneously for several courses.

During a given academic quarter, the student is enrolled in several courses (e.g., finance, statistics, marketing, organizational behavior). The student is presented with a problem statement which he must approach from the viewpoint of each course. This final product is one paper which simultaneously meets the requirements for all courses in the program. As a result, he is forced to abandon a strictly single disciplinary approach and at least consider as many aspects of the problem as there are courses. Typically the student will integrate other disciplines as well. Once the disciplinary boundries are removed, the student begins to look at problems from multiple viewpoints.

Each instructor reviews each paper from the viewpoint of his course to determine the extent to which the student has applied the concepts of that course to the problem. Conceivably, therefore, a student can do very well for one course and very poorly for another.

To a large extent, the burden of integration and interdisciplinary behavior is largely placed upon the student. The faculty do attempt to coordinate topics, but in the last analysis, it is the student who must emerge with the interdisciplinary orientation. In one sense, therefore, the Problem Laboratory is a method of conducting an interdisciplinary program with a disciplinary faculty. The Problem Laboratory forces at least a multidisciplinary if not an interdisciplinary approach by the student.

Problem Statments. The student in the Problem Laboratory is presented with a problem statement. Unlike a case, the problem statement is quite brief and describes a difficulty or set of difficulties facing a firm. The student obtains further information by making inquiries of the data base established for the organization.

Problem statments are carefully constructed to avoid stating causes of problems. The student, through his investigation, is expected to determine causes and formulate solutions. For example, suppose a firm had been experiencing declining revenues because of an increasing turnover of salesmen. The student, in the problem statement, would be told only of the declining revenue, not of the turnover in salesmen. It is the student's task to consider possible causes of this problem and to then ask the appropriate questions to explore the causes. Hopefully, he formulates many hypotheses about the problem. The more causes he considers, the more likely it is that he will consider and detect the correct ones.

The problems used in the MPL Program have focused exclusively on business firms. In the Urban Studies Program the focus will be on problems of cities: housing, transportation, crime, pollution, etc. While the focus will be different, the concept is identical. Students will begin with a statement describing a set of conditions and then proceed to investigate causes and generate solutions. The Urban Problem Laboratory will be closely linked with an interdisciplinary seminar on urban problems.

Hypothesis Formation and Testing. On a conceptual level, the essential feature of the Problem Laboratory is the development and testing of hypotheses about the cause of and solutions for problems. The student is presented with a problem situation and asked to explore that problem. Essentially, he must formulate hypotheses about the problem and test them using data which he obtains through interaction with the data base. The Problem Laboratory, therefore, is based on learning through concept development or hypotheses formulation, information search, feedback and concept modification.

The hypothesis-formulation, information-search learning behavior of students in the MPL is analogous to that of a medical student or physician. Typically, a patient presents a complaint structurally similar to the problem statements used in the MPL. That is, he presents symptoms of problems. The medical student is trained to develop many diagnostic hypotheses about what the cause of the complaint might be. The dangers of too quickly focusing on one hypothesis or the failure to consider alternative causes is perhaps more apparent in a medical context than

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in a business situation. Like the MPL student, the medical decision maker begins to gather data to test his diagnostic hypotheses by extracting information from the medical record, quizzing the patient, and performing laboratory procedures. He, like the MPL student, accepts, rejects, and refines his hypotheses until he is reasonably certain they explain the causes of the problem. These statements then form the basis for "solution" or "cure" hypotheses which again are tested in reaching conclusions about what course of action is to be taken.

The medical analogy is of interest for two reasons. First, it demonstrates the general nature of the hypothesis-formulation, information-search procedure in actual problem-solving situations. Secondly, it provides a model for explaining the process to students. They can easily identify with the role of the physician as a diagnostician and his subsequent information search to test his many hypotheses.

Program Evaluation. The MPL Program has been subjected to intensive evaluation over a two-year period. The results of this evaluation are presented elsewhere (1, 2, 3, 4, 5). In summary, students in the MPL achieved the equivalent disciplinary content acquisition as students in the regular program despite a nearly 40 percent reduction in formal lecture time. More importantly, the MPL students achieved significantly greater scores in problem solving, information utilization, motivation, and conceptual complexity. The data strongly indicates that the Problem Laboratory approach does lead to an increased ability to handle complex problem situations.

The Physical Component

The implementation of the Problem Laboratory concept as a successful program is dependent on a well designed data base, and a data base maintenance and retrival system. At this point, the concept of the Problem Laboratory is more fully developed than the physical system. The following sections discuss some of the problems of implementation and some anticipated solutions.

Access to Organizations. A firm can only be used with its full cooperation. Access is needed to financial statements, marketing plans, organization charts, etc. Quite understandably, some firms are unwilling to provide this type of data because of fears of competitive disadvantage. Continued emphasis must be placed on finding new firms to participate and to maintain the cooperation of those currently involved.

Fortunately, cooperation is not simply a one-way proposition. The firm, as well as the student and the University, has much to gain. Student reports are sent to the frim and frequently the officers meet with the students for seminars. These reports and meetings provide the firm with a different point of view regarding their problems. Student reports are also supplemented by the suggestions of the participating faculty. In effect, the firm receives consulting assistance in exchange for its cooperation.

On a continuing basis the achievement and maintenance of business support is essential. All too often the University is viewed by businessmen as impractical; even worse, many students view the curriculum as theoretical and not really relevant to business practice. The MPL Program has been helpful in dispelling some of these misconceptions. Businessmen in particular have been impressed by the insight and analytical skill of the students and by their interest in business problems.

Access to data for the Urban Studies Program should be significantly less difficult than for the MPL. The Urban Studies Program will utilize information such as crime statistics, census data, and other data readily available from federal, state and local agencies.

Building the Data Base. The data base is the crux of the Problem Laboratory. If the data base is structured well, the students can probe the problem and perform analyses. If it is done poorly, the students are quickly frustrated and disenchanted.

A data bank cannot, of course, ever be complete; some data is not available even to those in the organization. Nor is it desirable that a data bank contain all information. Part of the process of problem solving is learning to deal with situations in which there is incomplete information. Decision makers rarely operate in an environment of complete data.

Nevertheless, it is essential that great effort be placed upon building and maintaining a good data base. In the MPL Program, the data bank is built by having each faculty member build a list of data which he feels to be needed for a successful investigation of the problem from his point of view. In effect the faculty member is asked to analyze the problem prior to the beginning of the quarter. Not only does this increase the probability of building an adequate data bank, but it also increases his familiarity with the problem and as a result hopefully has a favorable impact upon classroom performance.

The data bank contains facts. A

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frequent initial difficulty of students in using the data bank is to submit evaluative questions rather than requests for facts. Evaluative questions are not permitted. For example, students are not permitted to ask "Are the salesmen adequately trained?" because it calls for a judgment and the data bank contains only facts. The student may ask questions such as "How many years of experience does each salesman have?" or "What is the formal education of each salesman?" The responses to these questions are to be used by the student to determine whether or not the salesmen have adequate training. The students are to make judgments, not the builders of the data bank.

Building a data bank is a continuous process not a one-time operation. No matter how carefully the planning, students will request information that was unanticipated. To a certain extent this is because the planning emphasizes the data that is needed for the problem. Students, however, frequently request seemingly irrelevant data. It is important that most such questions be answered because part of the learning process involves false beginnings and dealing with irrelevant information. The availability of data should not be a guide as to what is important.

The data gathering process, therefore, continues during the quarter in which the problem is being used. This is essential not only because of the unexpected questions but also to keep the problem up-to-date. During the eleven weeks of the quarter the organization undergoes change. It is essential that the student have access to this change to maintain the environment of real problems of real organizations. On occasion students meet with people from the organization to re-enforce the reality of the problem.

Storage and Retrieval. To date the storage and retrieval of data is handled entirely on a manual basis. Information is stored in written form in regular file cabinets. Students submit written requests for information and receive a written response. This manual system is rather cumbersome. It requires a large amount of storage space, consumes a large quantity of paper, and is somewhat difficult to update. These problems become increasingly serious as the program expands to include more students and more organizations.

A computerized information storage and retrieval system with terminal access would, of course, be a vast improvement over the manual system. Presently graduate students are used to retrieve information from the data banks. These students could be much better used to gather data to improve the quality of the data bank or to work with students rather than working on the laborious task of retrieving material from files.

The chief impediment to the development of a computerized system is cost. The software for the system has been developed at SIUE but at present the computer facilities are not adequate to support interactive terminals. Such facilities should be available within two years, and unless external support is obtained, the implementation of a computer based system will be delayed until that time.

An important question to be resolved, for either a manual or a computerized system, concerns the level of aggregation of data. That is, into how small of components should information be broken? For example, if a student asks for sales data by markets, should he receive a total for each market or a breakdown by product in each market? Ideally, the student should be given only that which he requests. However, since questions can be asked in a multiplicity of ways, it is difficult to structure the data base to achieve that goal.

This point is of importance because the Problem Laboratory approach is based on the premise that students should develop concepts or hypotheses and then test and refine these concepts or hypotheses through data search. If data is stored in too large of "chunks" then quite rapidly the student receives data which is not relevant to this hypothesis.

THE PROBLEM LABORATORY: A PUBLIC UTILITY

The data banks being developed at Southern Illinois University at Edwardsville have a large potential value to those outside the University. Problem Laboratory programs can easily be implemented in other environments by linking into the data banks at SIUE. The primary cost of developing a Problem Laboratory program is in the development of the data bank. Much of this cost could be eliminated if the data banks were computerized with access through remote terminals.

The data banks on business organizations would, of course, be most attractive to other schools with business curricula. The data bank for the Urban Studies Program, however, would have a clientele broader than just academic institutions. Various governmental agencies and planning groups might well wish to use the data base.

The sharing of the data base with other organizations not only reduces the cost of operation for one institution but it also makes it possible to increase

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the size of the data bank and, in the case of the business program, makes it possible to include a greater number of firms.

THE PROBLEM LABORATORY: A RESEARCH RESOURCE

The Problem Laboratory is also of great potential value for research on learning and decision-making processes. There are a number of important research questions that can be investigated using the Problem Laboratory format. Two such projects are described below.

Numerous important decision-making processes are quite poorly understood. Nevertheless, people do make these decisions and in many cases they are made well. It would be of great value to trace that process. In the Problem Laboratory, real decision makers could be observed as they retrieve information to determine what information is retrieved, the order of its retrieval, and the form in which it is requested. Insight into this process could be of significant value for the designers of management information systems. All too frequently these designers rely upon the decision maker's self analysis of his needs. It would be preferable to have these needs defined by behavior rather than self analysis.

A second area of research involves the learning process of students. By monitoring the student's interaction with the data base we can determine the extent to which he is examining the various components of the problem and the extent to which he is using data in the process. Faculty frequently observe that they can tell how well a student is doing in a course by the questions he asks. The Problem Laboratory provides the structure to monitor the retrieval process on a continual basis. By examining these questions the involved faculty can gauge progress even before the students are formally tested. Hopefully, such monitoring would form the basis for program adjustments.

CONCLUSION

The concept of a Problem Laboratory described in this paper is a broadly applicable methodology for the development of interdisciplinary problem-solving skills. While it has been successful as an experimental setting on a limited scale, significant problems must be addressed for large scale implementation. A computerized information storage and retrieval system would not only reduce the operational problems for a single institution, but it would also make the resources available to a broad range of organizations. A network arrangement would make this highly promising educational methodology available on a wide scale basis at a relatively low cost.

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